

# Scenario Modelling: A Holistic Environmental and Energy Management Technique for Building Managers

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# Paper Outline

Domain Review with Case Studies

Proposed Solution: Scenario Modelling

Demonstration

Conclusion

Future Work

# Key Domain Weaknesses

- Operation requires reliable **information**.
  - Current Solution: Organisations employ experts
- Current analysis **techniques**
  - Fail to account for the unique nature of buildings
  - Fail to provide a complete reference
- Absence of standards that regulate Energy Performance Practices during building operation.
  - Europe: EPBD, ESD
  - US
  - Global: ISO 50001

# Key Domain Weaknesses

- Manual transformation of available **data**
  - Subjective
  - Ad-hoc due to absence of standardised rule based data transformations and presentation formats
  - Absence of structured and standardised process, aided by appropriate **tools**
  - Not reproducible

# Domain Review: Case Studies

## Categories

External Drivers

Internal Drivers

Role

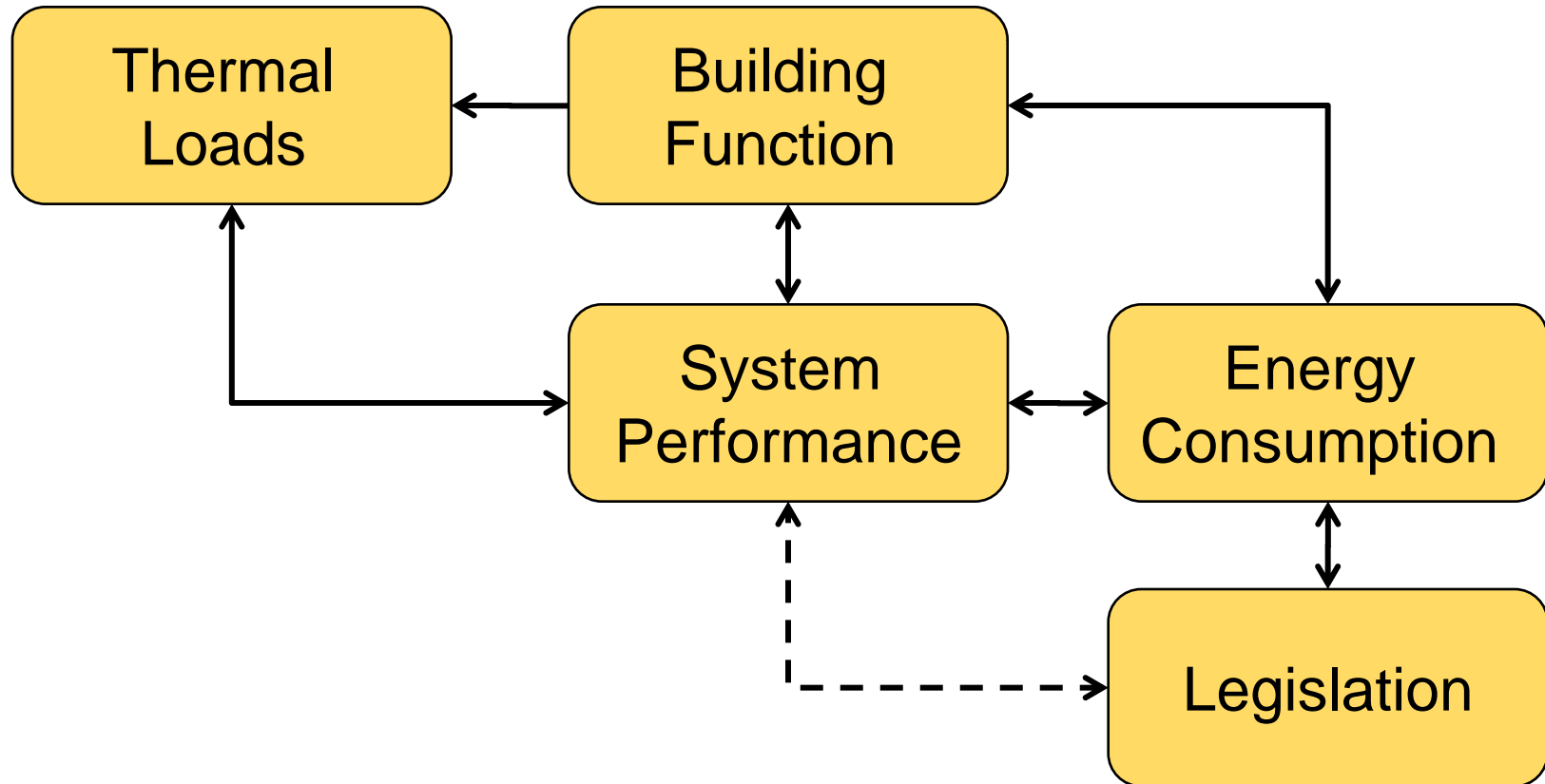
Data

Information

Tools

Techniques

# Requirements for Holistic Analysis

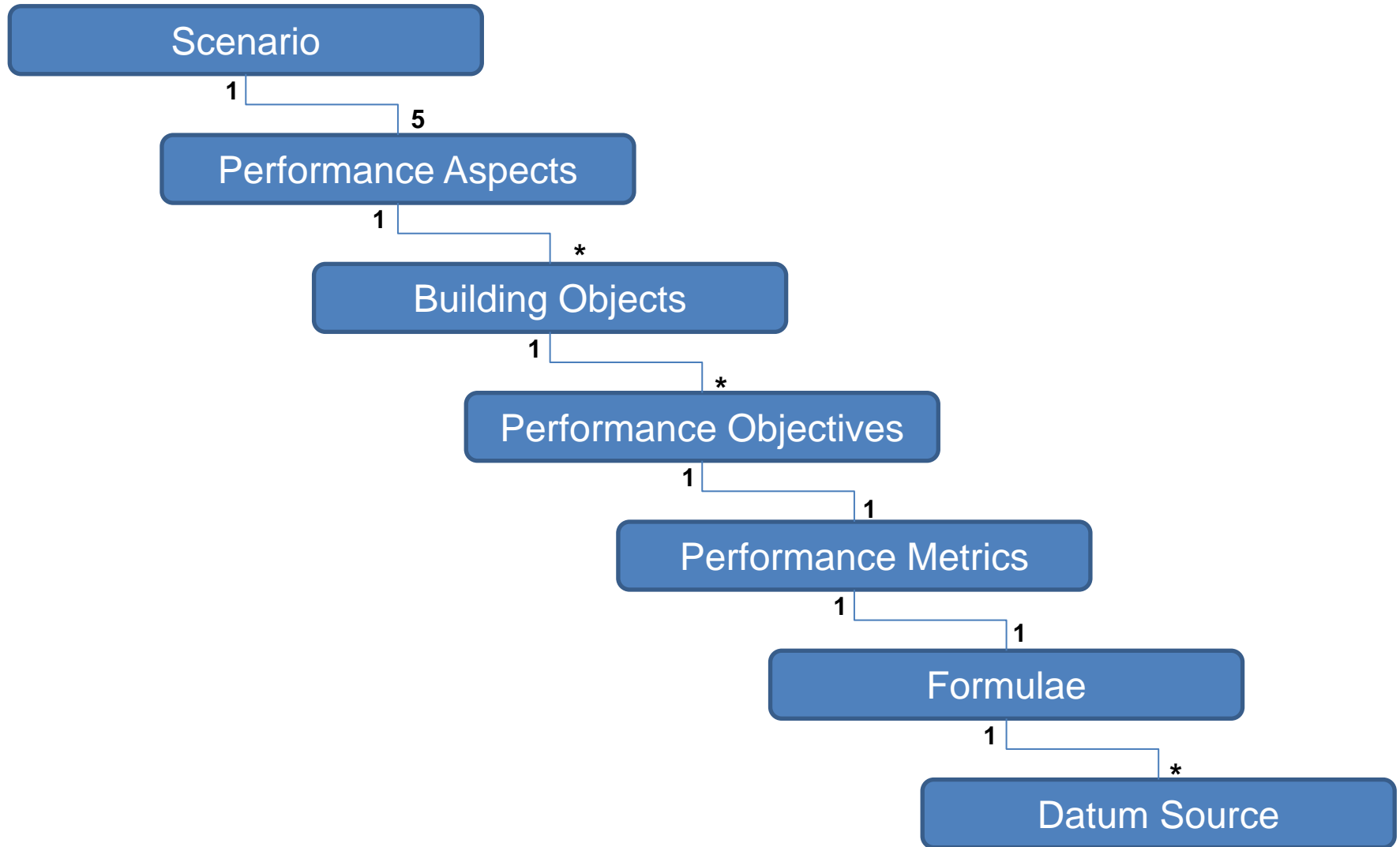


# Research Question

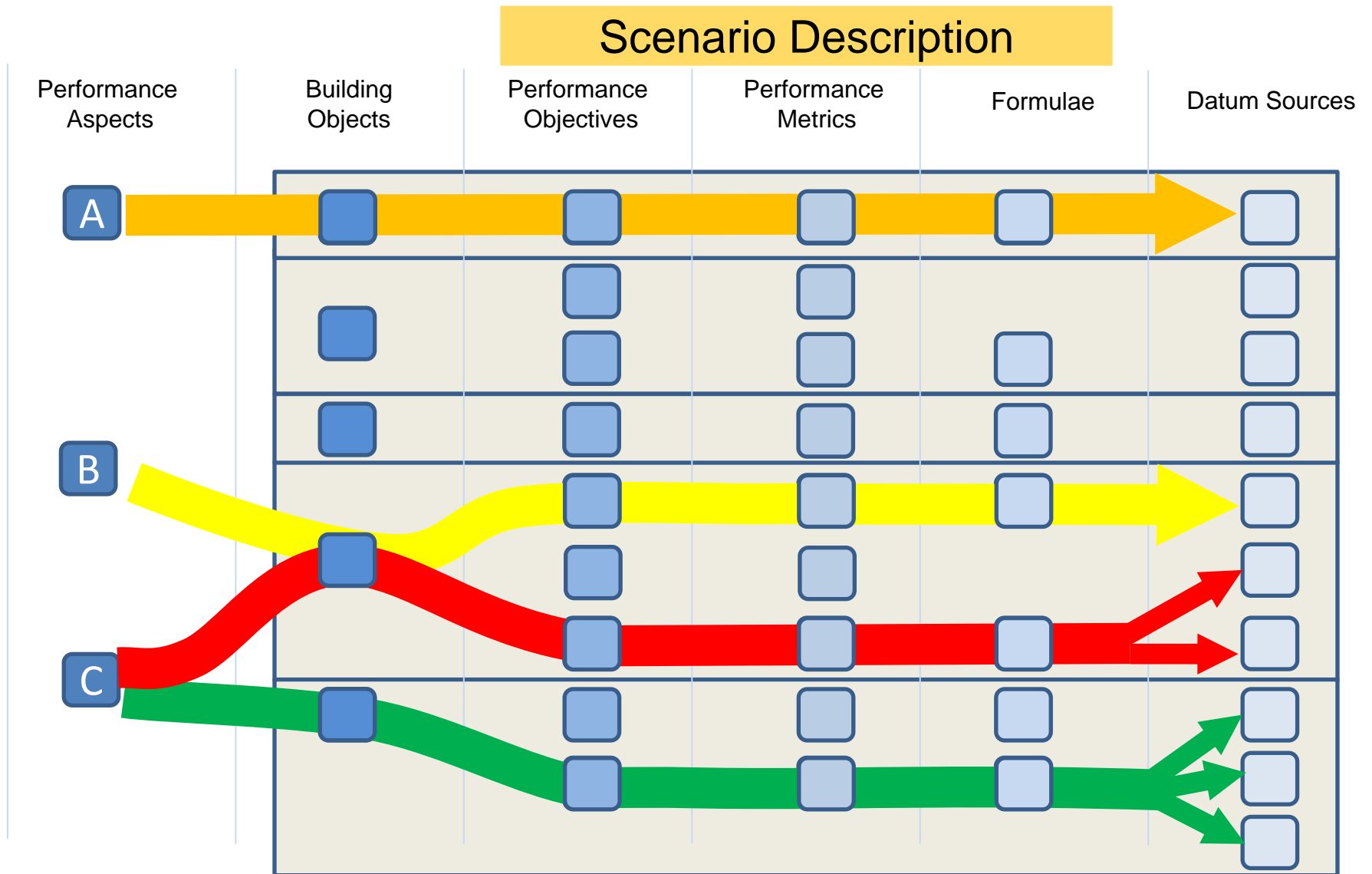
What is the optimal format for presentation of holistic building performance information to building managers?

# Scenario Modelling Technique

# Scenario Modelling: Class Representation

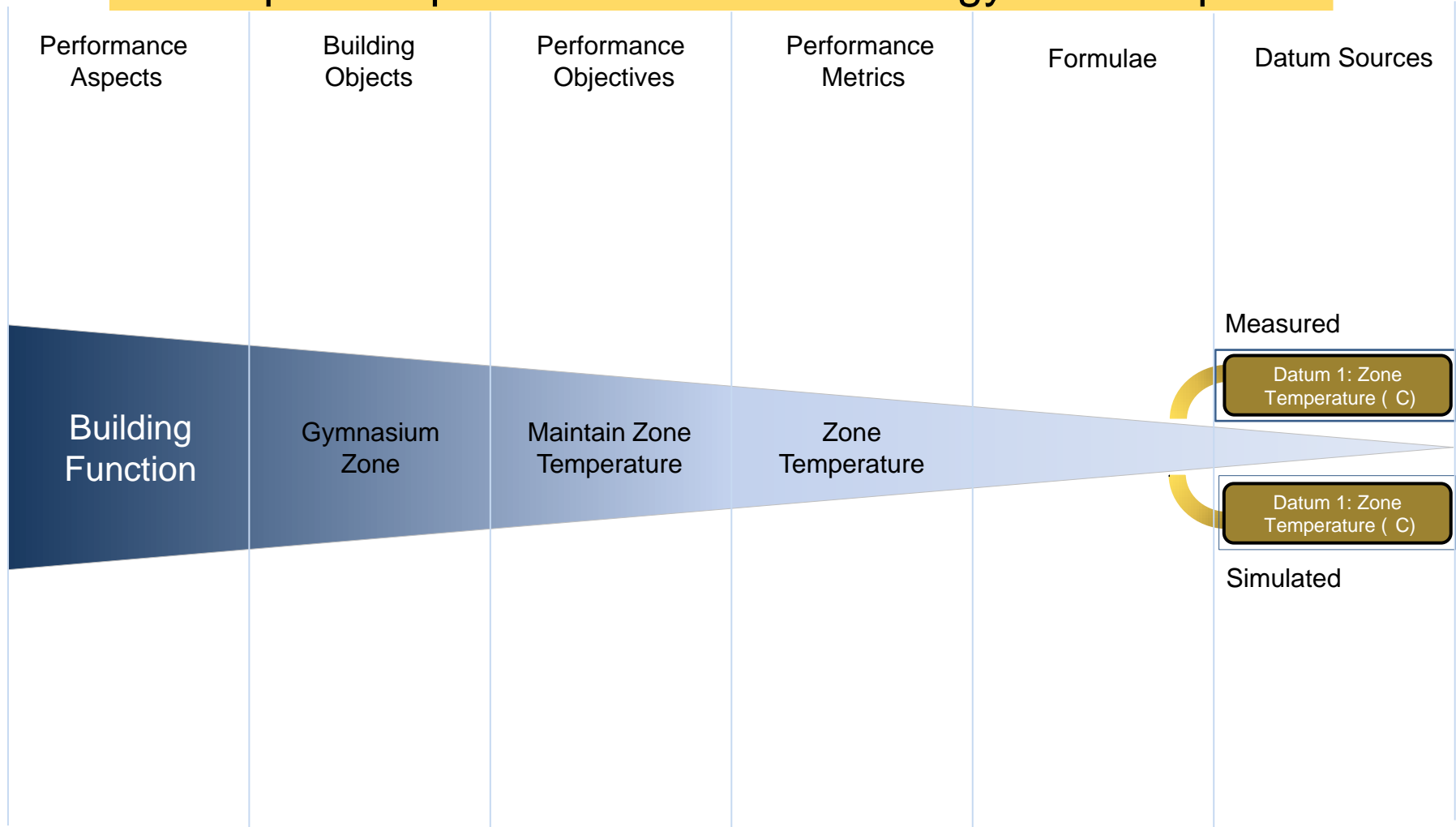


# Scenario Modelling: Concept



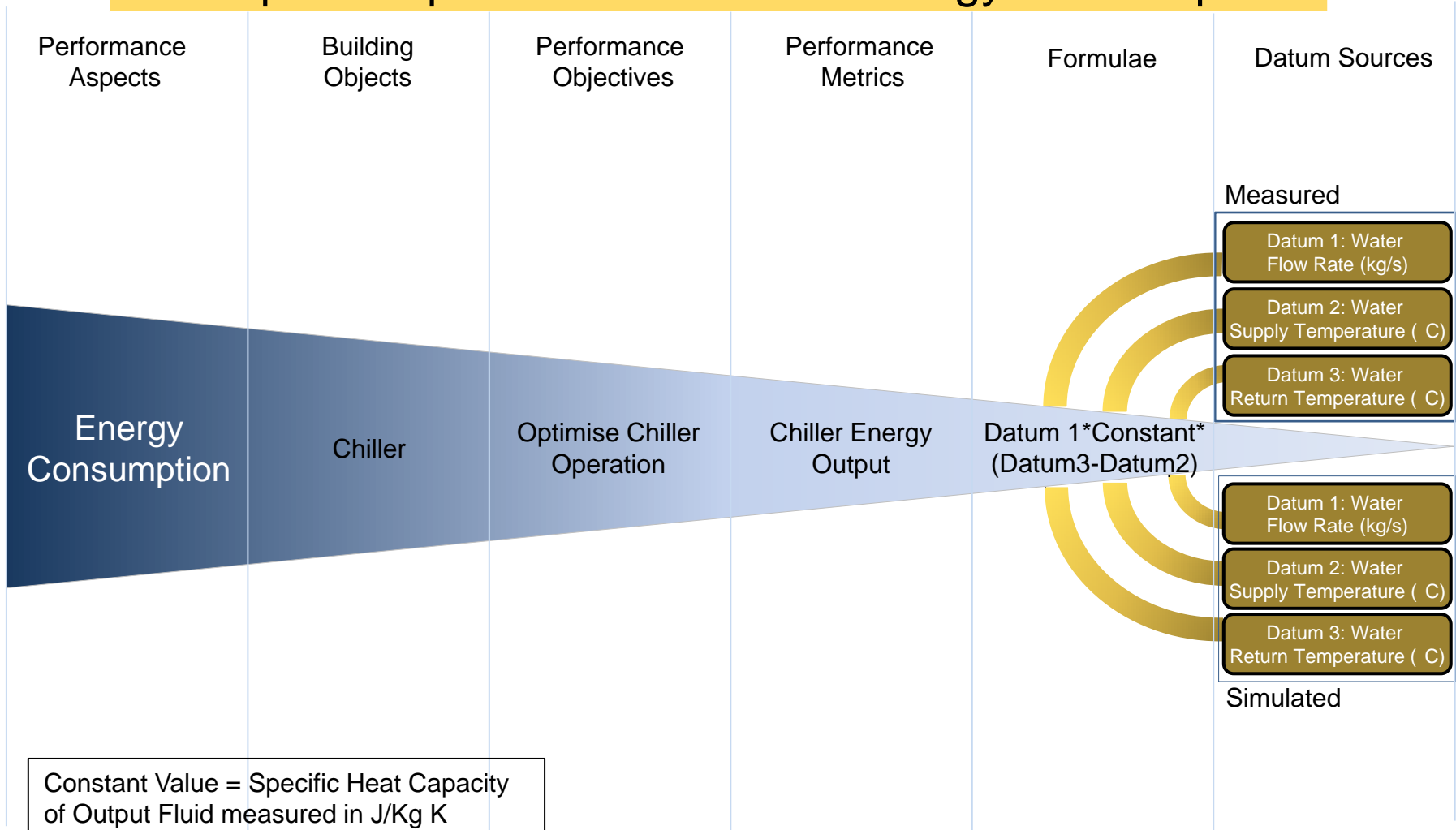
# Scenario Modelling Structure

## Example of Operation: Comfort V Energy Consumption



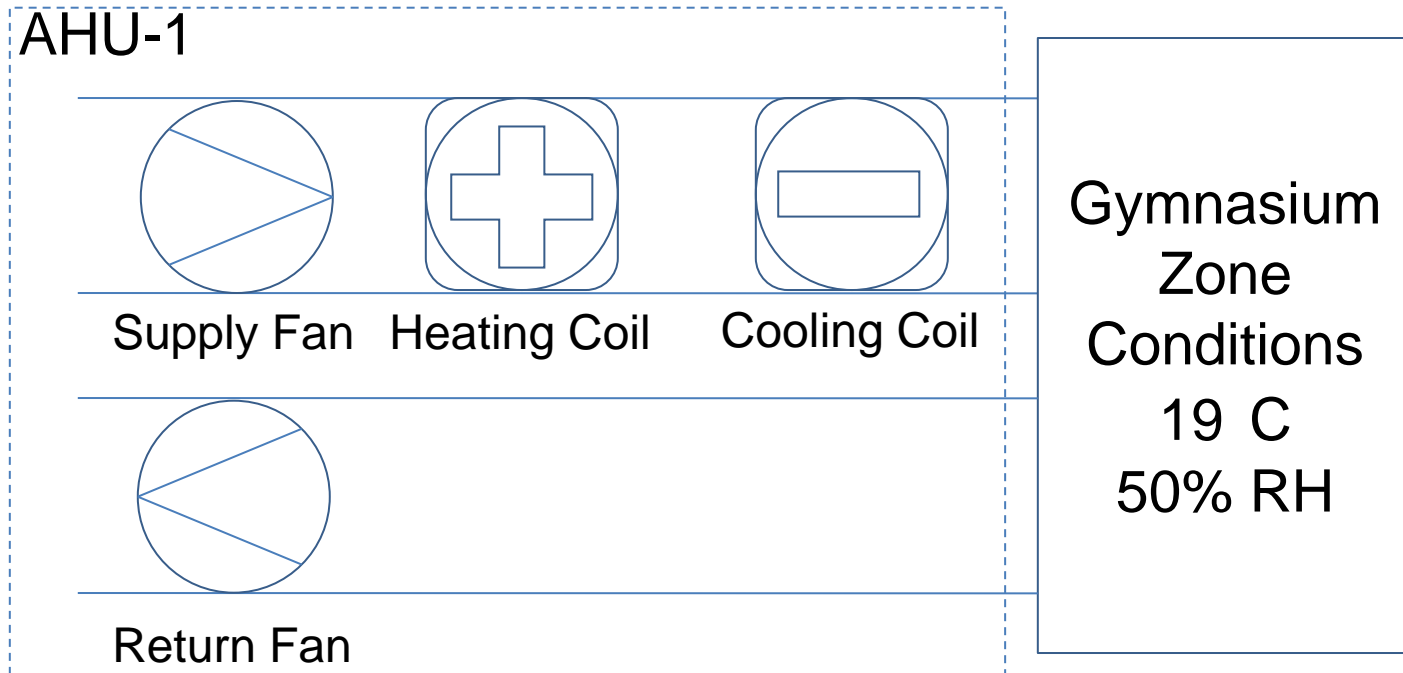
# Scenario Modelling Structure

## Example of Operation: Comfort V Energy Consumption



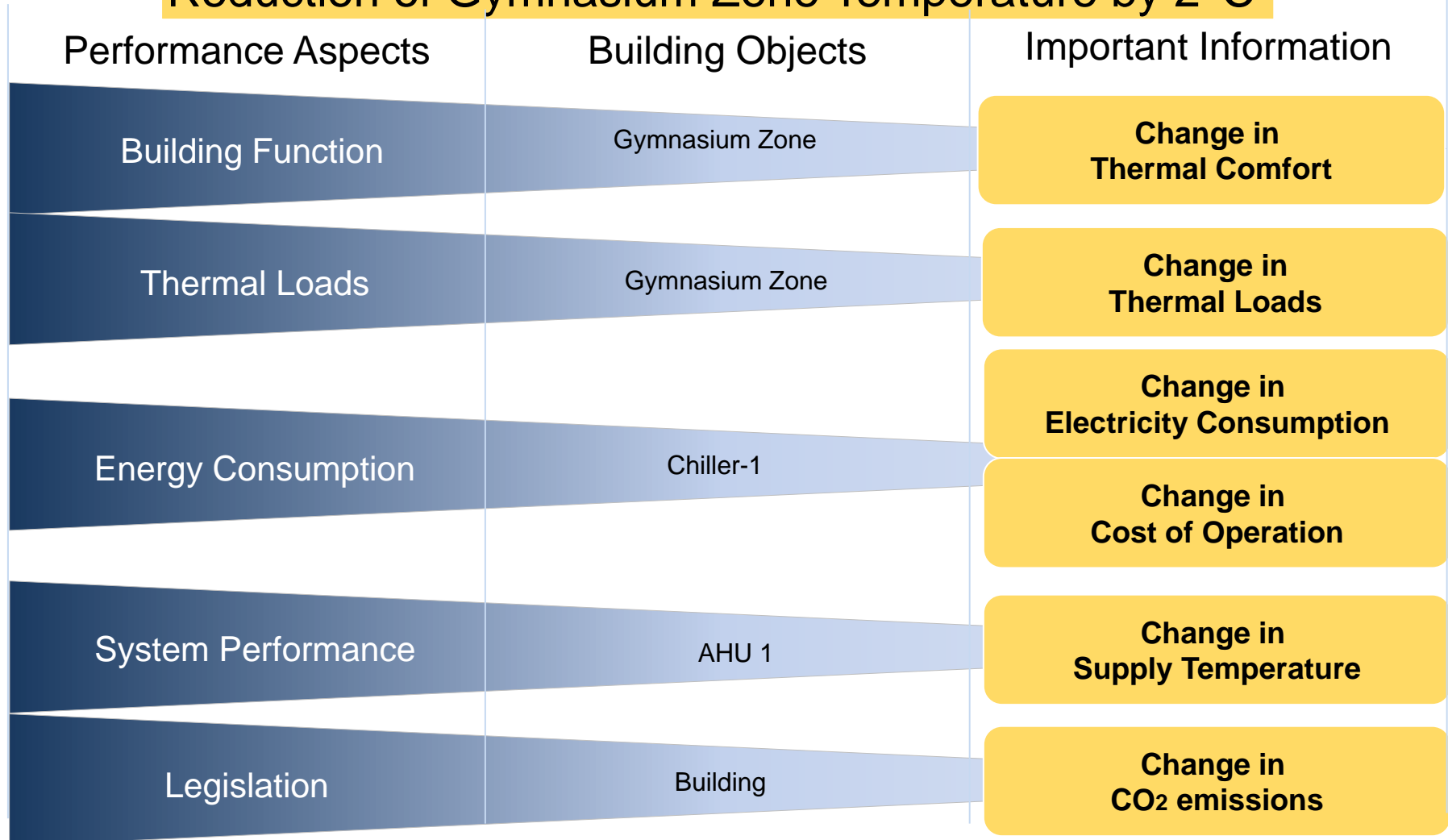
# Demonstration

# Example 1: Full Fresh Air System



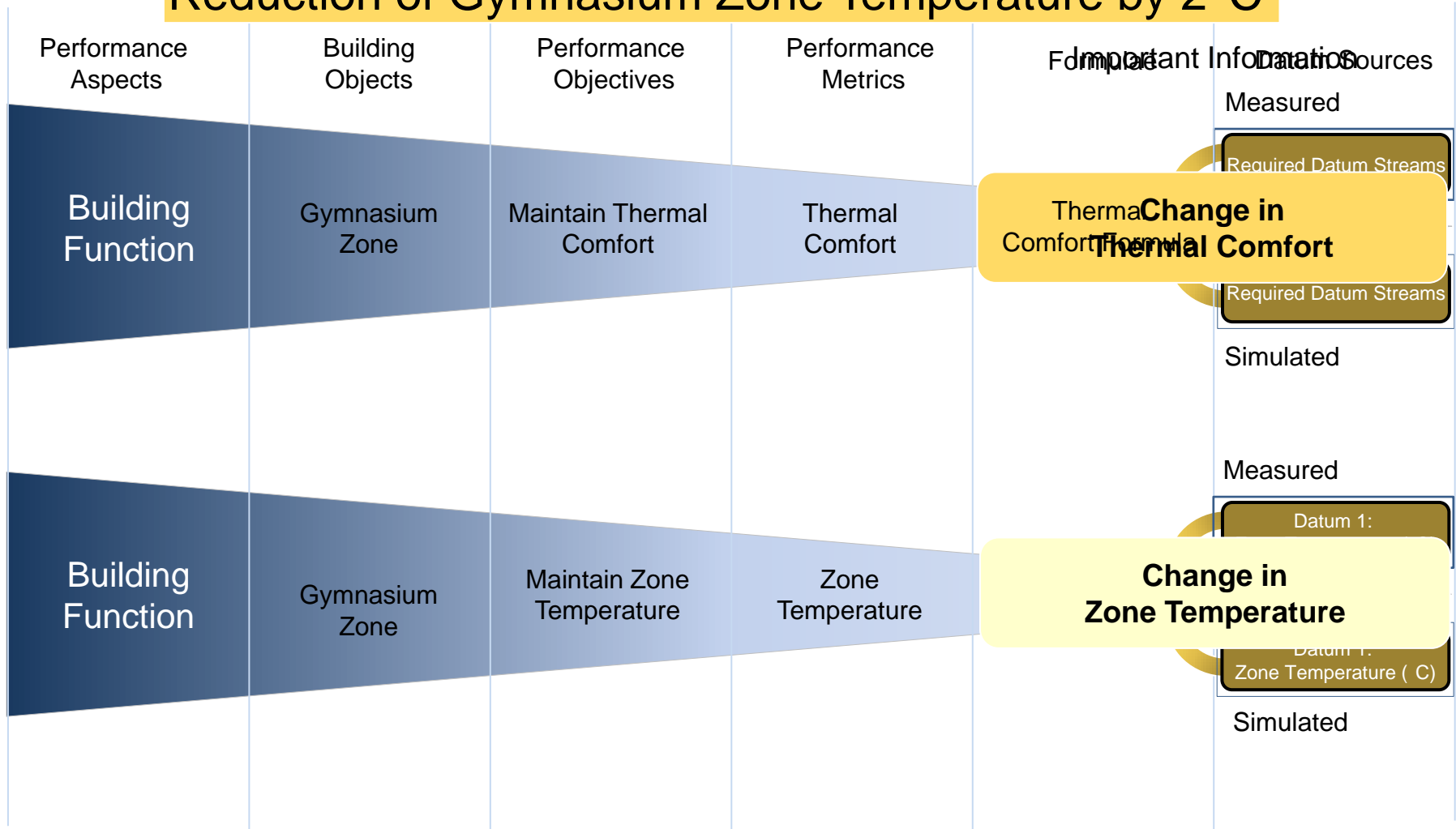
# Example 1: Summary of Important Information

## Reduction of Gymnasium Zone Temperature by 2 C



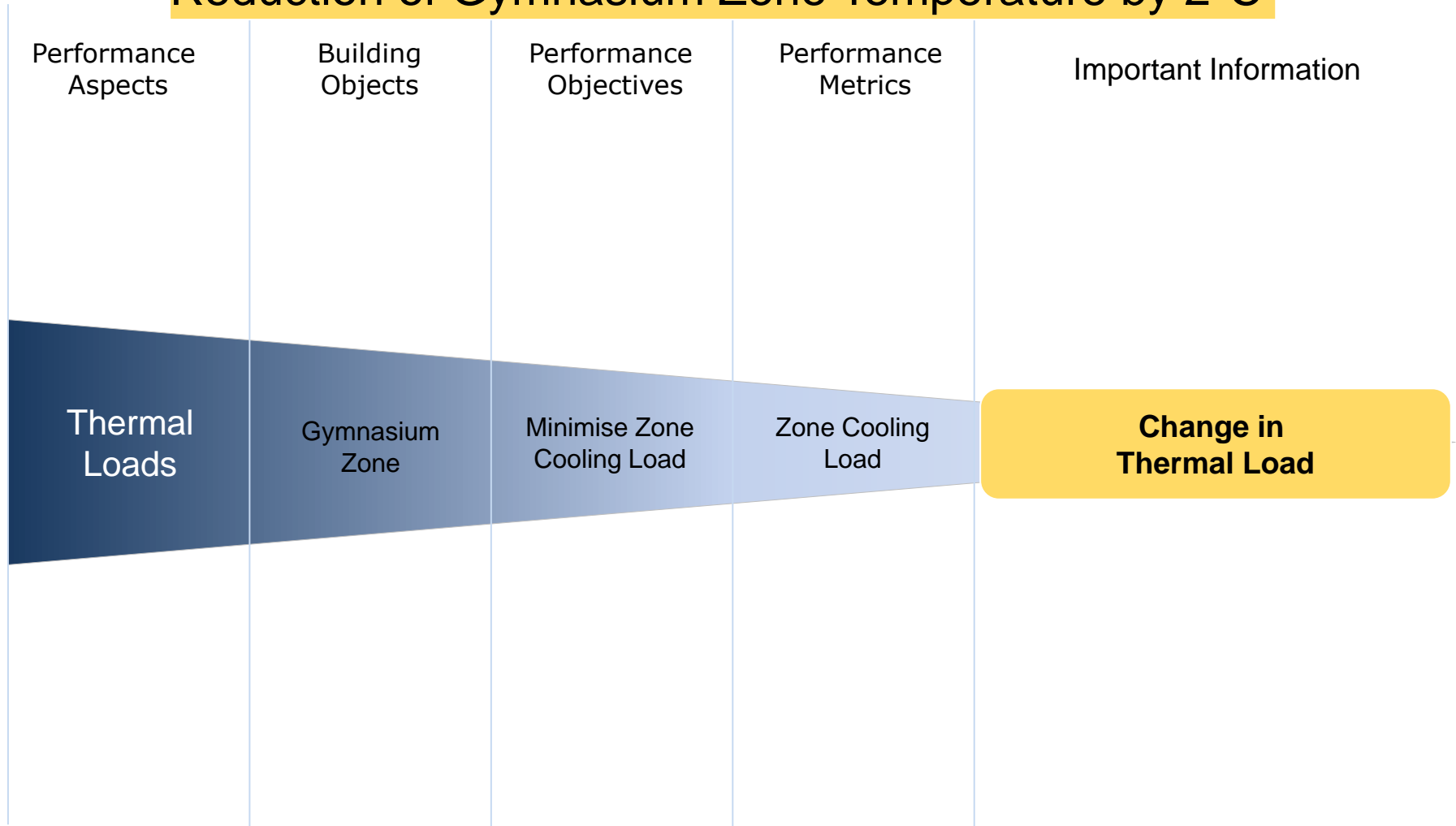
# Example 1: Building Function

## Reduction of Gymnasium Zone Temperature by 2 C



# Example 1: Thermal Loads

## Reduction of Gymnasium Zone Temperature by 2 C



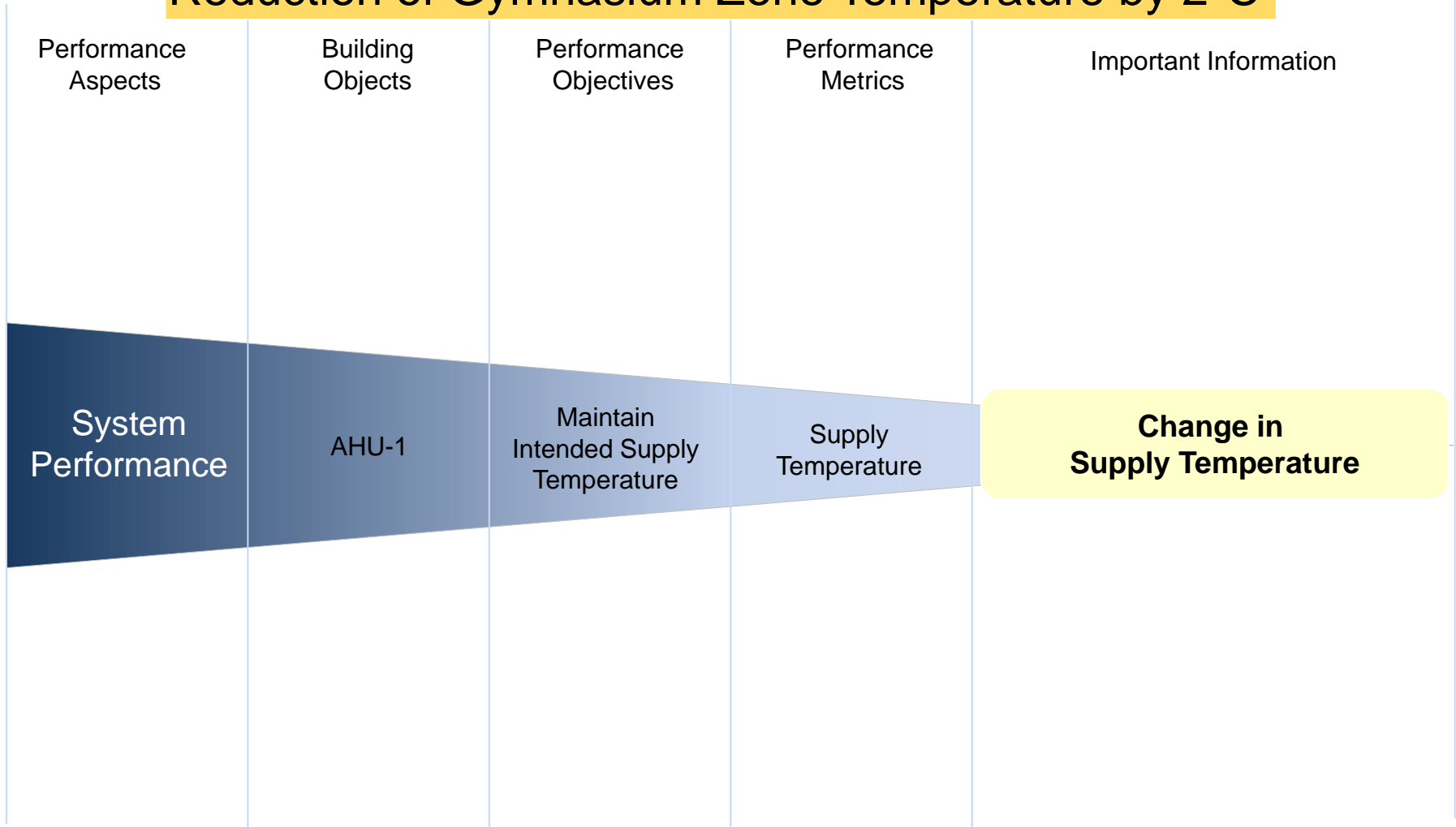
# Example 1: Building Function

## Reduction of Gymnasium Zone Temperature by 2 C

Performance Aspects	Building Objects	Performance Objectives	Performance Metrics	Important Information
Energy Consumption	Chiller-1	Minimise Chiller Energy Consumption	Chiller Electricity Consumption	<b>Change in Chiller Electricity Consumption</b>
Energy Consumption	Cooling Tower -1	Minimise Cooling Tower Loads	Cooling Tower Electricity Consumption	<b>Change in Cooling Tower Electricity Consumption</b>
Energy Consumption	AHU-1	Minimise Fans Energy Consumption	AHU Electricity Consumption	<b>Change in Electricity Consumption</b>

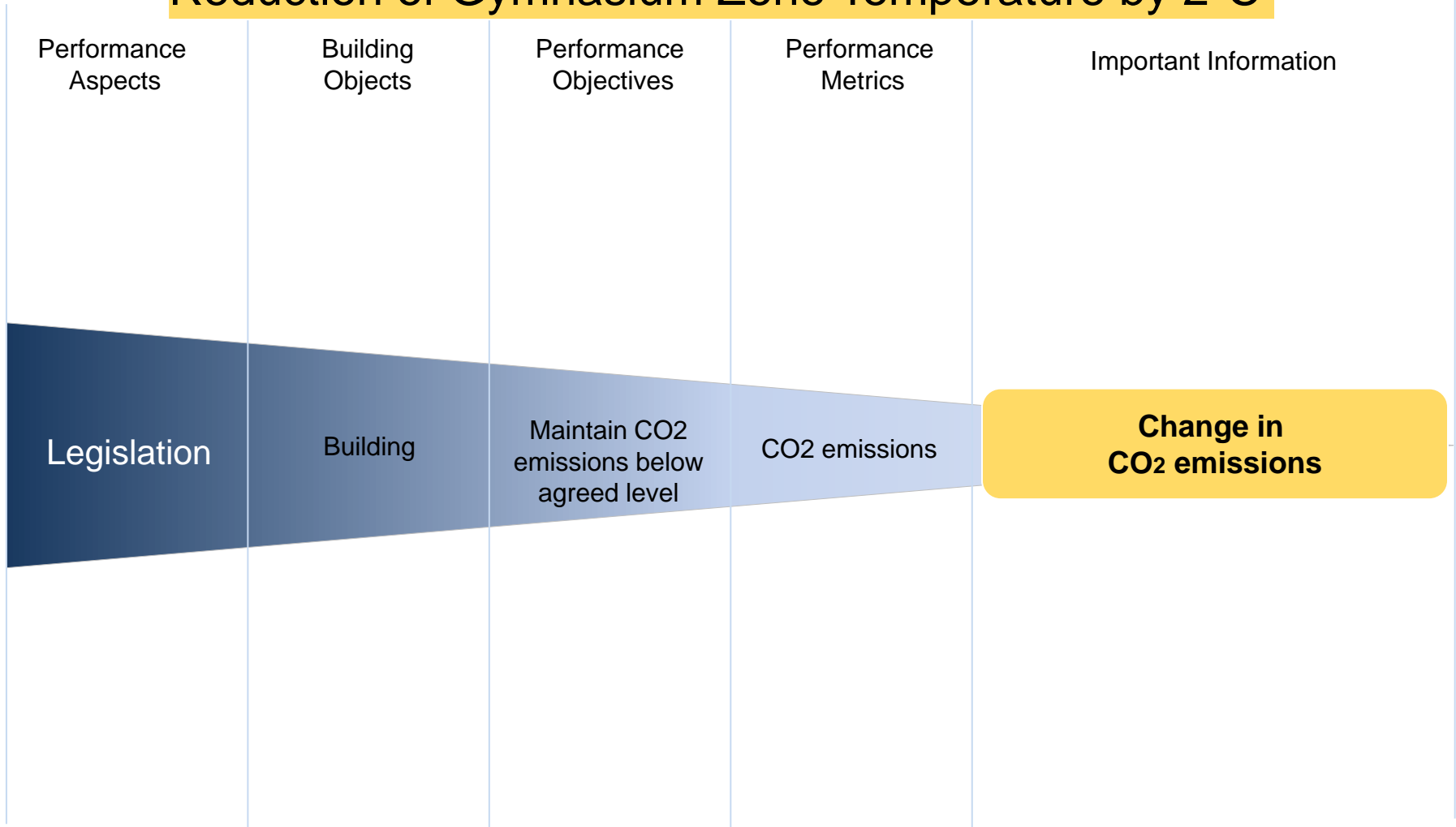
# Example 1: System Performance

## Reduction of Gymnasium Zone Temperature by 2 C

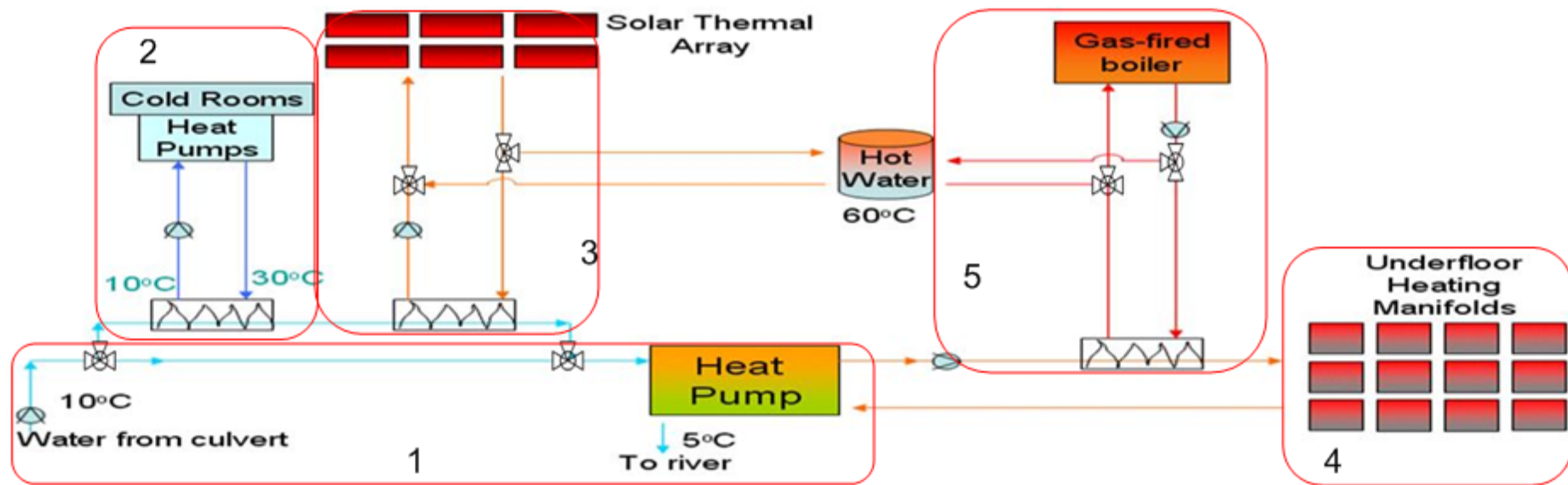


# Example 1: Legislation

## Reduction of Gymnasium Zone Temperature by 2 C



# Example 2: Hybrid Heating and Cooling System



# Example 2: Summary

## ERI Heating System Operation

Performance Aspects	Building Objects	Important Information
Building Function	ZG:05_Laboratory	No change in Thermal Comfort
Thermal Loads		No change in Thermal Loads
Energy Consumption	Heat Pump 1	Change in Electricity Consumption Change in Cost of Operation
System Performance	Heat Pump 1	Change in COP
Legislation	Building	Change in CO2 emissions

# Conclusion

# Conclusions

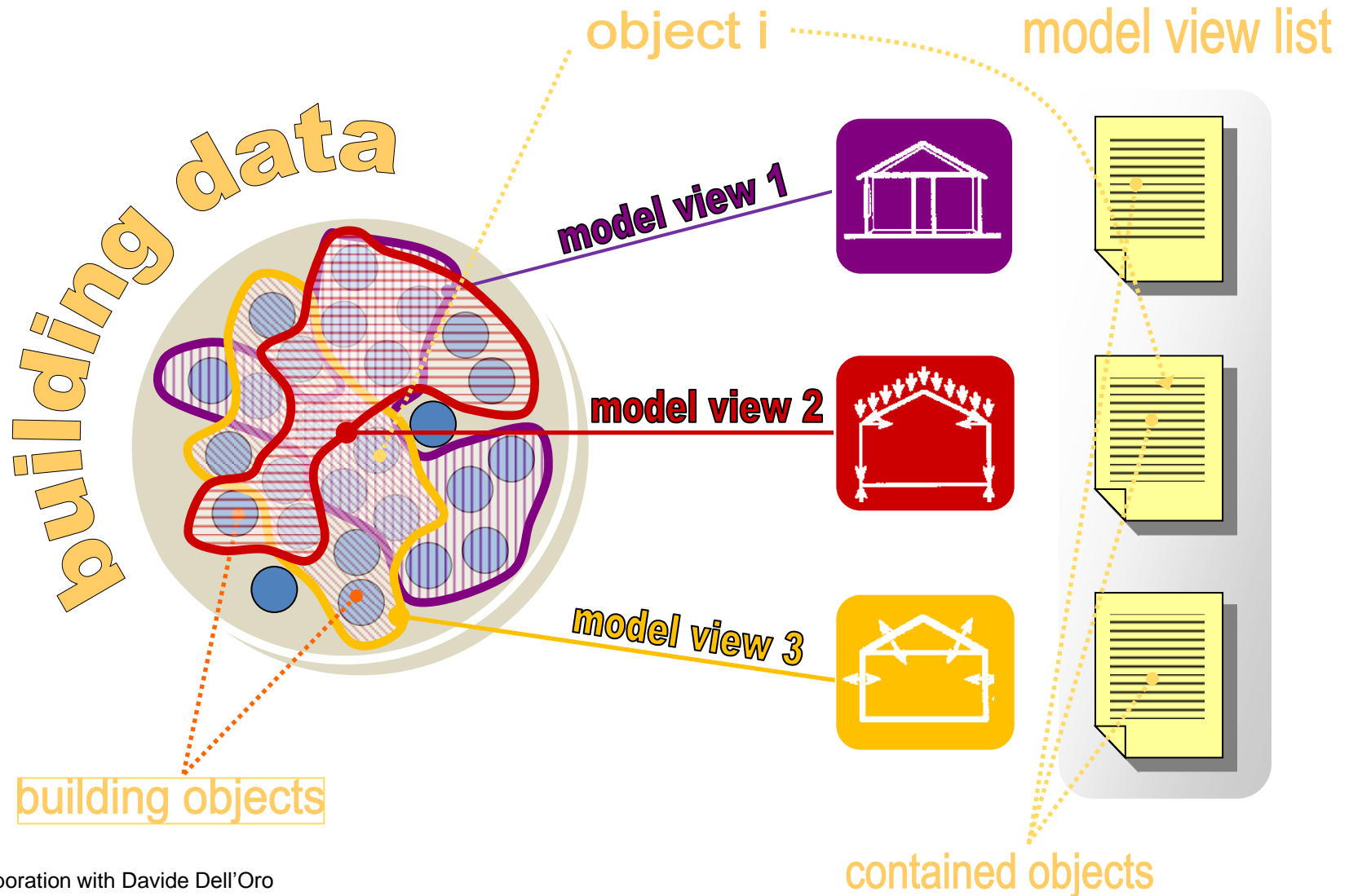
- Provides a standard technique that is applicable to all buildings
  - Eliminates ad-hoc and arbitrary data manipulation
  - Meaningfully relate actual operation back to design intent
- Benefits Fiscal Managers
  - Optimises building manager's time
  - Optimises system operation
  - Reduces energy consumption
  - Saves money

# **Future Work**

# Future Work

- **Customise** technique for other project stakeholders
  - Owners
  - Fiscal Decision Makers
  - Designers
  - Commissioning Consultants
  - Other
- Develop **Scenario Templates** for existing buildings
- **BLC Database** and **Environment** for Scenario Models
  - Accounts for data diversity
    - Simulation model output
    - Utility tariff

# Future Work: MVD for Building Operation



In Collaboration with Davide Dell'Oro

**Any Questions?**